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FEDERAL COMMUNICATIONS COMMISSION
OFFICE OF SECRETARY

September 4, 1996

William F. Caton, Acting Secretary
Federal Communications Commission
1919 M Street N.W., Room 222
Washington, D.C. 20554

RE: CC Docket 96-45

Dear Mr. Caton:

On August 28, 1996 the undersigned met with Bob Loeb and Anthony Bush of the FCC Common Carrier Bureau staff to provide documentation material on the Benchmark Cost Model 2. The attached material was provided.

In accordance with Commissioner Rule 1.1206(a)(1), two copies of the letter are being filed with you for inclusion in the public record. Acknowledgment and date of receipt are requested. A copy of this transmittal letter is provided for this purpose. Please contact me if you have questions.

Sincerely,



cc: Bob Loeb
Anthony Bush

No. of Copies rec'd 041
DATE SEP 11 1996

BENCHMARK COST MODEL 2

Overview

The Benchmark Cost Model 2 (BCM2) will install to a BCM directory and create state subdirectories by executing the Setup.bat file located on the CD. The BCM2 is made up of three EXCEL version 5.0 workbooks. The BCM2CNTL.XLS is a controlling workbook that contains the license agreement, registration and user interface. The BCM2.XLS is the processing workbook that contains the input tables, main logic or methods and summary reports. The SUMMASK.XLS is a summary results report with graphs. To run BCM2, retrieve the workbook BCM2CNTL.XLS. From the user interface screen, you can select the state or states to process, opt to print the summary report or save the workbook. You can also change the cable breakpoint or a benchmark cost value. Once the BCM2 is saved, you must retrieve the saved model (*st*BCM2.XLS where *st* is the state abbreviation), the user interface is no longer available on a saved BCM2.XLS workbook.

Installation

Execute the Setup.bat file located on the CD. The BCM2 will install to a BCM directory, create state subdirectories and move the appropriate files to the subdirectories. You must enter a one character drive letter (C thru Z) during the installation process, this drive can be a desktop or LAN drive. The CD contains about 75 meg of data so make sure you have ample disk space available on the drive before installing. If you have limited disk space, you can install BMC2 manually by creating the appropriate BCM directory and state subdirectories and then move the XLS's to the BCM directory and *st*DTIN2.XLS files to the state subdirectories.

Instructions for Running BCM2

Retrieve the file BCM2CNTL.XLS from the BCM root directory. If retrieving for the first time, you will be asked to input a one character drive letter, enter the same one that was used in the installation instructions above. After the drive letter is entered, the workbook will resave itself so that this question will not be asked again. You can change the drive letter at any time by using the CHANGE DRIVE LETTER button on the Control sheet of the workbook.

Read the license agreement and press the I ACCEPT THIS AGREEMENT button to continue. If you do not accept this agreement, the model will terminate execution.

The processing can be a lengthy process depending on the number of CBG's and the speed of your computer. Typically, a state with 3000 CBG's will take approximately 20 minutes to process if you have a machine with 128 meg of memory and 120 megahertz processor.

Single State Processing

Select the state to process from the list box (Territories are not yet available). You have the option of changing the cable breakpoint or the 80 dollar benchmark cost value by selecting the ADDITIONAL OPTIONS button on the Control sheet. Press the PROCESS SELECTED STATE OR STATES button to continue processing the BCM2. After processing the state, you can save the workbook to your hard disk by pressing the SAVE WORKBOOK button. This will save as *st*/BCM2.XLS where *st* is the state abbreviation. You have the option to create a summary results file by selecting the SAVE RESULTS button. This creates a file named *st*_RSLTS.XLS which is the same report as the SUMMARY tab of BCM2.XLS, the only difference is the graphics package.

Multi State Processing

Select the states to process from the list box (Territories are not yet available). You have the option of changing the cable breakpoint or the 80 dollar benchmark cost value by selecting the ADDITIONAL OPTIONS button on the Control sheet. Whenever you run multi state, you must select the ADDITIONAL OPTIONS button and specify whether you want to print each states summary report or to save each workbook or Summary Results files. Press the PROCESS SELECTED STATE OR STATES button to continue processing the BCM2. At completion of the processing, the last state selected will remain open. The workbooks will be saved as *st*/BCM2.XLS where *st* is the state abbreviation.

Retrieving a Saved BCM2 Workbook

Once the BCM2.XLS workbook has been saved, you can no longer go through the user interface in BCM2CNTL.XLS. Just retrieve the workbook *st*/BCM2.XLS, if asked to re-establish links, press the No button. You can then move around the workbook as you like. You cannot however, change any calculations on the Main Logic sheet. The Main Logic sheet was not set up to print so if printing is necessary, you must go through the File, PageSetup options on the EXCEL menu bar.

Changing The Input Tables

If you want to change a user input on the Table Inputs sheet, you should do this before you process a state. The calculation time on the model can be quite long. It usually is faster to rerun the model with the changed input then to change the input and recalc the workbook. To change the inputs, retrieve the BCM2.XLS workbook and select the Tables Input Tab. Change the inputs and resave the file as BCM2.XLS. Then run as instructed above. To get back to the original BMC2.XLS workbook, copy the file from the CD to the BCM directory.

Running 1 company through the Model

The best way to run one company through BCM2 is to start with the *stDTIN2.XLS* input file. Save off a copy of the original files before you start. Retrieve the *stDTIN2.XLS* input file and sort by company name. Remove the unwanted companies by deleting the appropriate rows. Resort the file by Clli and Quandant and resave the file as *stDTIN2.XLS* and then run BCM2 as described above. If you have 2 or more input files, you must remove the unwanted companies from each file and resave. If you want the original files restored, rename them as the *stDTIN2.XLS* input file.

Instructions for loading and Running BCM2.

1. **Execute the Setup.bat file located on the CD.**
This will setup you directory structure and copy files to the appropriate location
2. **Retrieve the file BCMCNTL.xls from the BCM root directory. Read the license Agreement and press the I Accept This Agreement Button to continue.**
3. **Select the state/states to process.**
4. **Select the Other Options Button if running multistate through the BCM2. This allows you to save and/or print the states as they are processed.**

THE FCC IS REWRITING AND UNDERMINING THE TELCOM BILL

In its decision released August 8, 1996 implementing the Telecommunications Act of 1996, the FCC has taken actions which clearly undermine the careful balance that Congress wrote into this historic piece of legislation, and which seriously threaten the objectives which Congress sought to achieve. Specifically:

WHAT CONGRESS INTENDED:

As local telephone companies, long distance companies and cable companies were allowed to enter each other's business they would build competing networks, stimulate investment and create new jobs.

WHAT THE FCC DID:

By pricing "unbundled network elements" so low (see below) there is no incentive for new market entrants to build competing networks.

WHAT CONGRESS INTENDED:

Prices for new unbundled network elements were to cover their costs and earn a reasonable profit.

WHAT THE FCC DID:

By cleverly redefining the meaning of "cost", the FCC was able to develop artificial costs far below the costs which LECs experience in providing telephone service. They did this in two ways:

1. For the pricing of elements, the FCC has defined a new economic term called "Total Element Long Run Incremental Cost" (TELRIC). TELRIC seeks to determine not the cost of providing the element today, but rather what it might cost if we could totally rebuild the telephone network using the most current technology available. In a declining cost industry such as telecommunications, this guarantees that no company would ever be able to earn a profit.
2. In modeling the TELRIC cost of the local network, the FCC is not using the network as it exists today, but instead is modeling a "fantasy network" with much less equipment (and therefore lower costs) than the network necessary to provide service at the levels of quality expected by our customers and demanded by our regulators.

WHAT CONGRESS INTENDED:

Congress sought to have the rates for interconnection and unbundled network elements set by negotiation of the parties, and only if negotiations were unsuccessful, to be set by the state regulators.

WHAT THE FCC DID:

The FCC issued complex rules, cost formulas and understated "proxy price ranges" for state regulators to use in arbitration. These rules eliminate any incentive for new entrants to negotiate with incumbents, and tied the hands of state regulators in fulfilling their role in implementing the intentions of congress. NARUC has recently announced its intent to appeal the FCC's decision on these grounds.

WHAT CONGRESS INTENDED:

Parties would be given a fair chance at competing for customer's business by restricting the joint marketing of long distance and resold local services until after the local incumbent had been given permission to enter the long distance business.

WHAT THE FCC DID:

While the joint marketing restriction does apply to services purchased at "wholesale" (retail price less wholesale discounts) it specifically exempts unbundled network elements from the joint marketing restrictions. Since these elements are priced so low, this provision guts Congress' intentions for a fair start of local competition.

These actions by the FCC will clearly cause different results from the legislation than those which Congress intended. Their effect will be to transfer significant wealth from the local exchange carriers to the long distance carriers with no significant change in the underlying service options that customers have, and with none of the expected job growth and economic stimulation. If the principles embodied in the Interconnection decision are carried forward into the upcoming Access Reform and Universal Service proceedings, then the clear intentions of Congress for the preservation of affordable basic services for all Americans could also be placed in danger.

Benchmark Cost Model 2

Methodology

Introduction

The purpose of the model is to estimate a benchmark cost of providing basic local telephone service for both business and residence customers in small geographic areas for the entire U.S. and its territories. Small geographic areas are used because the cost of providing basic telephone service varies greatly even within the geographic unit of the wire center. Thus, the use of small geographic areas allow the model to identify specific areas which are high cost to serve because of the physical characteristics of the area.

The BCM2 assumes all plant is placed at a single point in time. All facilities are created as if the entire country is a new service area. Therefore, the BCM2 reflects the costs a telephone engineer faces installing new service to existing population centers.

BCM2 is a geographically-based high level engineering model of a hypothetical local network. The basic geographic units used by the model are Census Block Groups (CBGs), as designated by the U.S. Bureau of the Census. There are over 226,000 covering the entire U.S.¹ The basic data provided by the Census Bureau are the geographic boundaries of the CBG, the geographic center (centroid) of the CBG, and the number of households in the CBG. In addition to the Census data, terrain information from the U.S. Geologic Survey (U.S.G.S.) is developed by CBG. This information includes data which impacts the cost of placing telephone plant into service. The terrain data includes water table depth, depth to bedrock, hardness of the bedrock, surface soil texture, and the slope of the terrain. Another data item developed by CBG is an estimate of the number of business lines. This number is developed based on a third party data base of employees by CBG. These preceding items contain all the CBG characteristics necessary for input to BCM2.

The BCM2 starts with the existing central office locations throughout the country. The source of the central office locations is Bellcore's Local Exchange Routing Guide (LERG). This data is input into a geographic information system where each CBG is associated with the closest central office. Once all CBGs are associated with central office locations, this information plus the relative physical locations and CBG information are input to the BCM2. This basic input information allows the BCM2 to design a local exchange network utilizing a tree and branch topology.

¹ BCM2 is capable of using any small geographic unit, such as a census block or the "grid". Utilized by the Cost Proxy Model (CPM) developed by Pacific Telesis and INDETEC.

BCM2 methodology is presented below in the following sections:

- Assumptions for Loop Technology
- Assumptions for Feeder Plant Architecture
- Assumptions for Distribution Plant Architecture
- Assumptions for Switch Technology
- Assumptions for Density
- Algorithms to Develop Basic Local Service Costs
- User Adjustable Inputs

Prior to addressing BCM2 methodology a brief description of the major model changes from the original BCM is provided in the following section.

Major Changes From BCM to BCM2

Based upon public comments and analyses of the BCM, a number of enhancements have been incorporated into BCM2. These enhancements are designed to more accurately reflect actual engineering practices in the development of a local exchange network. BCM2 includes all costs of basic local telephone service, whereas the BCM only included the major cost drivers that differentiated high cost and low cost areas. The major changes from BCM to BCM2 follow.

Population Distribution

The BCM2 rural CBG input data are modified by a Geographic Information System module to reduce the square mile area of the CBG to an area that reflects the clustering of households. This is done utilizing a third party road network database to identify the areas within the CBGs which have the highest probability of containing households. A 500 foot buffer is created on each side of roads in CBGs with 20 households per square mile or less. A new area is calculated by the buffer area. If road buffers overlap, the area is not double-counted.

Business Line Information

The BCM2 includes business lines, private line loops, as well as residential lines by CBG. State specific counts for reported business lines and private line loops are allocated to CBGs based on a third party data base of employees by CBG. Additional residential demand beyond a single line per household is included based on the national ratio of all residential lines reported in the end of year 1994 as a ratio of 1990 households.² The

² BCM2 has a user variable input for the number of lines per household. The default value is 1.2.

inclusion of these lines allows the realization of all economies of scale associated with loop plant within the wire center.

Engineering Assumptions

Additionally, there are four major areas where the engineering assumptions changed from BCM to BCM2: switching plant, distribution plant, feeder plant, and the placing of a cap on wireline loop investment.

The BCM2 switching module changes includes five switch sizes to more closely reflect the switch application. The new switch module uses the Local Exchange Routing Guide information for remote switch locations to place remote switches in the locations where they are currently installed. Additionally, stand alone switch sizes of up to 10,000 lines, 10,000 to 60,000 lines, 60,000 to 100,000 lines and over 100,000 lines are used.

The BCM2 distribution plant engineering has been altered to reflect the distribution demands of each CBG. Varying the distribution plant engineering assumptions in urban areas aligns the BCM2 engineering designs more closely with actual engineering practices in these areas. This is done by basing the number of distribution plant cable legs on the number of housing lots in each CBG. The original BCM utilized a simplifying assumption of a constant four distribution cables per CBG.

Another distribution plant enhancement is that no copper distribution distances exceed those specified by the user. The maximum copper distribution distance is a user input with a 12,000 foot default. The limitation of copper technology serving distance has the effect of producing multiple distribution areas within rural CBGs, which in effect extends the feeder plant facilities into the CBG. This change also aligns BCM2 more closely with actual engineering practices. The original BCM assumed all plant within the CBG was copper distribution plant and that there would always be four distribution cables.

Two other areas of distribution plant engineering changes are driven by high concentrations of business lines in a CBG. The first change is that if a CBG line count exceeds 2,016, a variable percentage of lines will be terminated at the DS1 level to reflect costs of providing service to digital PBXs and providing wideband private line services. This is a user variable input. Additionally, if line demand for a single CBG exceeds the capacity of a maximum size copper cable, fiber will be deployed to the CBG regardless of the distance.

The third major area of engineering assumption change is that the costs for feeder plant digital loop carrier (DLC) systems reflect the fixed and variable nature of the costs. This ensures that the cost for DLC equipment properly reflects the effects of the equipment loading in each CBG. This is an important change since there can now be multiple remote terminals within a CBG for two reasons. First, the inclusion of business lines can cause the line demand to exceed that which can be provided by a single remote terminal. Second, the maximum copper distribution distance can cause the deployment of multiple remote terminals.

The final major area of change is the assumption that an alternative wireless loop technology is utilized for loops requiring investment levels in excess of the cost of an alternative wireless technology. Based upon ongoing trials, a value of \$10,000 per loop is used in BCM2.

Other Enhancements

There are a number of other enhancements included in the BCM2. The BCM2 includes costs of the local loop not previously reflected in the original BCM³, slope data is included in the BCM2 input data, and new variables that impact structure costs are available for future use. Another area of change provides separate annual cost factors for cost items that are plant related and a separate annual cost factor for line-related expenses. Three separate plant related factors are utilized for cable and wire facility investment, circuit equipment investment, and switch equipment investment.

Model Methods

Assumptions for Loop Technology

Feeder cable (cable placed so that it can be supplemented at a later date) is deployed as analog copper plant where the total loop distance is less than the user-specified maximum copper cable length.⁴ If the loop distance exceeds the maximum loop distance value, fiber feeder plant is deployed. Fiber Feeder may extend into the CBG to maintain the maximum copper distribution cable distance.

Distribution plant may contain analog copper technology when terminating signals at a voice grade level, or may utilize fiber loop technology or digital

³ BCM2 includes costs for the pedestal, drop wire, network interface device, in-line terminals, splicing and engineering.

⁴ The user may specify maximum copper distances of 9,000 feet, 12,000 feet, 15,000 feet, or 18,000 feet.

carrier on copper, when terminations are made at the DS1 signal level for a percentage of business lines.

BCM2 uses two types of DLC equipment depending on the number of lines needed at each remote terminal location. For a remote terminal requiring line capacities greater than 240 lines, Lucent Technologies SLC Series 2000 equipment is used. For remote terminal requiring 240 lines or less capacity, Advanced Fiber Communications equipment is used. Both products are deployed in drop/add configurations, with SLC having a total capacity of 2,016 voice grade channels per four fibers and AFC having a total capacity of 672 voice grade channels per four fibers.

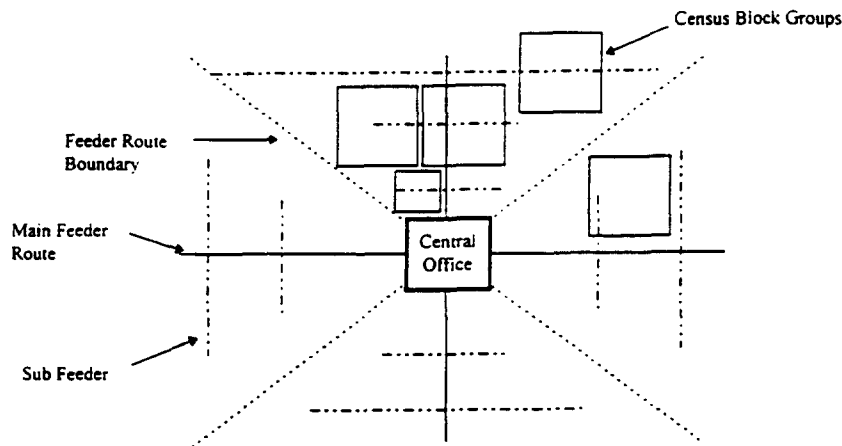
Assumptions for Feeder Plant Architecture

Feeder plant uses a tree and branch topology, with plant routes intersecting at right angles. Each feeder cable begins at the central office and generally ends at a terminal at the edge of a CBG. However, fiber feeder may extend into the CBG to ensure that the user specified maximum copper cable length is not exceeded.

Four main feeder routes leave each central office⁵: directly East (quadrant 1); directly North (quadrant 2); directly West (quadrant 3) and directly South (quadrant 4). The feeder route boundaries are at 45 degree angles to the main feeder routes.

⁵ A central office may have less than four feeder routes if no CBGs are located within a feeder quadrant.

Feeder Plant Architecture



Both copper and fiber feeder cables share the structure and placement costs in the main feeder systems. As the main feeder routes move away from the central office and deploy cable capacity to the CBGs, the feeder cables taper in size to the capacity necessary for each individual segment.

Copper feeder cables range in size from 25 pair cable to 4,200 pair cable, while fiber feeder cable sizes range from 12 strand cable up to 144 strand cable. Feeder plant costs include the material cost of cable and electronics, as well as the capitalized cost of structure and placing the cable, electronics costs at the central office and remote terminals, as well as costs of in-line terminals, splicing and engineering.

Assumptions for Distribution Plant Architecture

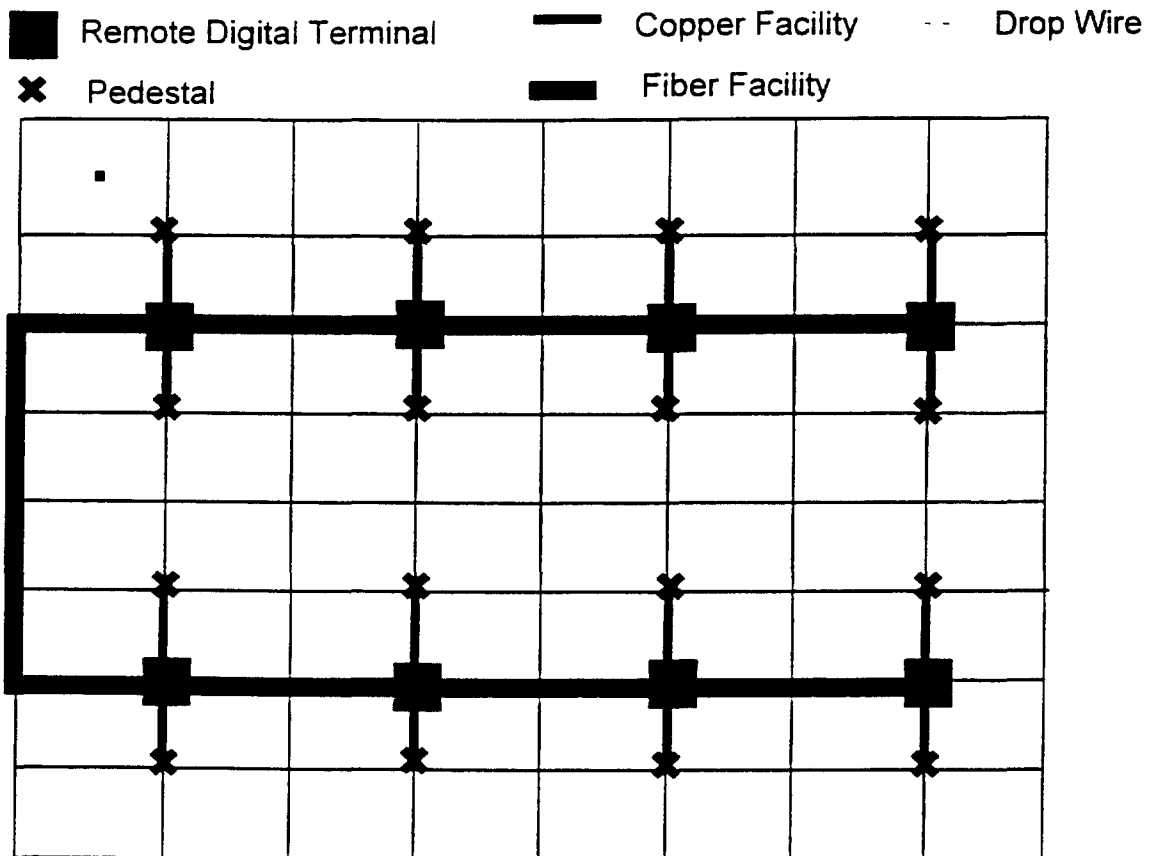
The BCM2 assumes that all households within a CBG are uniformly distributed. In rural areas, the CBG area input data has been reduced reflecting the removal of areas that do not have road access.

Distribution cable begins at the end of the feeder cable and continues to the customer premise. The distribution plant is designed to reach all households in the CBG through the placing of cables between subdivision lot lines.

BCM2 more precisely designs distribution plant for each CBG to ensure cables pass by each premise. The number of distribution cables may be as few as one for a small CBG to 20 or more cables in more densely populated CBGs.

In larger rural CBGs, it may be necessary to extend the fiber feeder into the CBG itself to maintain copper cable lengths less than the user specified maximum. An example of fiber extending into the CBG is displayed below.

Example of Distribution Plant With Fiber



Investments for distribution plant include the material cost of the cable and its cost of structure, as well as the network interface device, the drop wire, the pedestal, in-line terminals, digital terminals, splicing and engineering. Distribution cable sizes range from 12 pair cable to 3600 pair cable.

Since business lines are now included by CBG, the BCM2 distribution architecture uses fiber distribution cable in very dense CBGs that require

larger cable capacity than a maximum size copper distribution cable. Additionally, BCM2 terminates a percentage of the lines in these dense CBGs at a digital DS-1 signal level, since a percentage of businesses have digital PBXs or wideband services that utilize such capacity.

Assumptions for Switch Technology

The BCM2 uses five different size generic digital switches for calculating switch investments. Using Bellcore's LERG information, a switch is designated as a remote switch or a stand-alone switch. Stand alone switches are split by line size grouping: up to 10,000 lines; 10,000 lines to 60,000 lines, 60,000 lines to 100,000, and over 100,000 lines. Each size switch has a unique fixed or start up cost and a unique per line cost. The start up cost includes central processor frames, billing and data recording equipment and frames, miscellaneous power equipment and back-up power, the main distribution frame, frames for testing, and basic software.

Assumptions for Density

CBG densities are calculated in a three step process. First, the business lines are divided by a user input density adjustment. The default value for the density adjustment is 10 business lines occupying the physical space of one household line. In the second step, the adjusted business lines are summed with the CBG households. Finally, this sum is divided by the square miles of the CBG. This insures that the proper density characteristics are assigned to the CBG.

The BCM2 uses six different density groups to determine characteristics of the plant being used. The six density groups are as follows:

- 0 < and <= 5
- 5 < and <= 200
- 200 < and < 650
- 650 < and <= 850
- 850 < and <= 2,550
- > 2,550

The density groups determine the mixture of aerial and below ground plant, feeder fill factors, distribution fill factors, and the mix of activities in placing plant and the cost per foot to place plant. These are all user adjustable inputs.

Terrain Assumptions

U.S.G.S. data for four terrain characteristics that impact the structure and placing cost of telephone plant are included as inputs to BCM2 by CBG. These terrain variables include depth to water table, depth to bedrock, hardness of bedrock, and the surface soil texture. Combinations of these characteristics determine one of four placement cost levels. The normal placement cost for a density group occurs when neither the water table depth nor the depth to bedrock is within the placement depth for the cable and the surface soil texture does not interfere with plowing activities. The next higher level of placing cost occurs when either the surface soil texture does interfere with normal plowing activities or soft bedrock is within the cable placement depth. The third level of placing difficulty occurs when hard bedrock is within the placement depth of copper cable or fiber cable. The last level of placement cost difficulty occurs when the water table is present within the placing depth of copper or fiber cable.

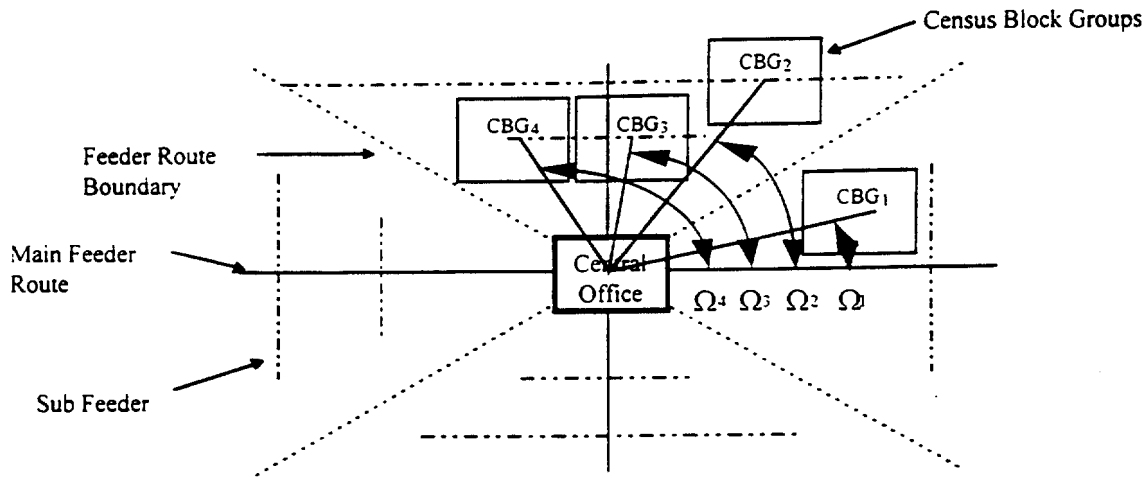
Algorithms to Develop Basic Local Service Costs

Feeder Plant Distance

Typically, each LEC central office has four main feeder routes, radiating out from the central office (BCM2 uses an East, a North, a West, and a South main feeder routes). Branching off from the main feeders are sub-feeders, typically at right angles to the main feeder, giving rise to the familiar tree and branch topology of feeder routes. Subscribers or homes are somewhat randomly spread within the route serving areas. The routes become less densely populated as the distance from the central office increases.

The geographic centers (centroids) of the CBGs may fall in any of the four feeder route serving areas. In order to determine on which of the four main feeder routes (or quadrants) a CBG is served, an angle Ω is calculated. The angle Ω represents the counter-clockwise rotational angle between a line connecting the CBG with the closest central office and a line headed directly east from the central office. This is displayed in the figure below.

Determination of Feeder Quadrant



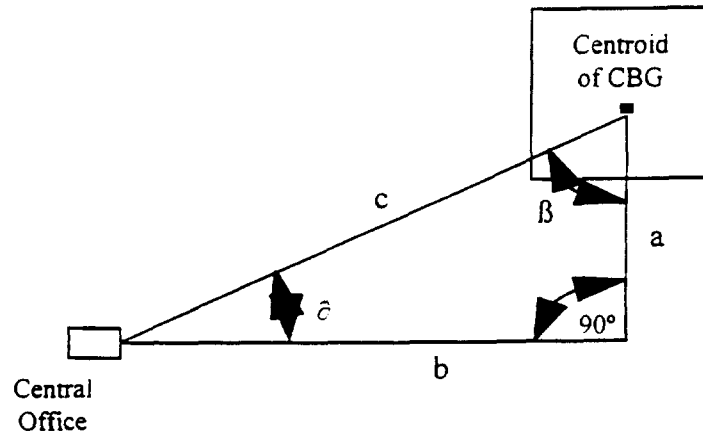
The relationship between the angle Ω and the feeder route is found in the table below:

East Feeder Route (Quadrant 1)	$315^\circ \leq 45^\circ$
North Feeder Route (Quadrant 2)	$45^\circ \leq 135^\circ$
West Feeder Route (Quadrant 3)	$135^\circ \leq 225^\circ$
South Feeder Route (Quadrant 4)	$225^\circ = 315^\circ$

To estimate feeder plant costs for a given CBG, the length of the feeder cable from the closest central office to the CBG is approximated. For purposes of simplification, it is assumed that each CBG is square in shape, with the households within the CBG distributed uniformly. As discussed, in CBGs with less than 20 households per square mile, CBG area is reduced to eliminate non-populated areas. Additionally, it is assumed that sub-feeder cable generally ends at the edge of the CBG, unless the CBG boundary overlaps the main feeder route, in which case no sub-feeder plant is used. Thus, calculating the feeder distance becomes a two-step process.

First, an airline distance is calculated using the latitude and longitude of the closest central office and the latitude and longitude of the centroid of the CBG. Next, the airline distance is converted to an equivalent feeder plant route length. This conversion becomes a simple mathematical model.

Feeder Distance Calculation



Airline distance between the central office and CBG centroid = Line c

Angle between Main Feeder Route (Line b) and Line c = α

Main Feeder Route Distance to CBG = Line b = $c \cdot \cos \alpha$

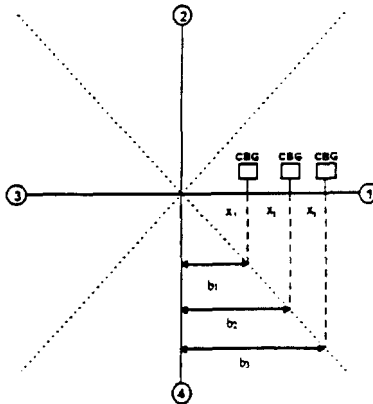
Sub-feeder route distance is calculated in a similar manner, however, the sub-feeder does not extend into the CBG.

The preceding distance calculations may be increased if the minimum or maximum slope measurements for a CBG reach the trigger values. If the slope is greater than the trigger value, then the feeder and sub-feeder distance are increased by a user specified factor.

Shared Feeder Plant Distance

CBGs that are served along a common feeder route share feeder facilities. The BCM2 calculates the distances for the shared feeder segments by calculating the Line b distance described above for each CBG in a quadrant. Once the Line b distances are calculated, the model sorts the CBG data first by central office, then by quadrant, and finally by Line b distance. An example of three CBGs in main feeder quadrant 1 is shown below.

SHARED FEEDER DISTANCE CALCULATION



In this example, there are three feeder segments in quadrant 1, main feeder segment X_1 , main feeder segment X_2 , and main feeder segment X_3 . The formula for calculating the feeder segment distance is:

For n (the number of CBGs within a quadrant) > 1 ,

Main feeder segment $X_n = b_n - b_{n-1}$

The total feeder distance for a CBG is the sum of main feeder distance and sub-feeder distance.

Cable Capacity and Material Investments for Shared Feeder Plant

The required capacity of a segment of copper feeder plant is determined by the sum of the lines of all CBGs utilizing that particular segment and copper technology. Next, the sum of these lines is divided by the fill factor for the density group associated with the segment. This calculation yields the copper cable capacity required for the segment. The BCM2 then “looks up” the cable capacity in a table to determine the actual cable size available (and its associated cost per foot) to meet the segment capacity. If the required capacity is greater than the size of the largest available cable, the BCM2 determines the number of maximum size cables and the next size cable to meet the capacity needs of the segment. The copper feeder cable sizes available in the model are 25, 50, 100, 200, 400, 600, 900, 1200, 1800, 2400, 3000, 3600, and 4200 pair.

The required capacity for a segment of fiber feeder plant is determined in a similar manner, however, SLC technology and AFC technology cannot share fiber strands because of differing transmission parameters. For SLC systems, four fibers can carry up to 2,016 voice grade paths. If the segment capacity exceeds this limit, four additional fibers are required for each increment of 2,016 voice grade paths. For AFC systems, four fibers can carry up to 672 voice grade paths. Like SLC, each additional increment of 672 voice grade paths capacity requires an additional four fibers. The voice grade paths are determined by technology by summing the lines by CBG utilizing the particular technology and dividing the sum by the fill factor associated with the density group of the feeder segment.

The total capacity for a fiber feeder segment is the sum of the required SLC fiber strands and required AFC fiber strands. The BCM2 determines the number of maximum size fiber cables and the size of the additional fiber cable to meet the capacity needs of the segment. The fiber feeder cable sizes available in the model are 12, 18, 24, 36, 48, 60, 72, 96, and 144 strands.

Once each feeder segment's cable size and cost per foot is determined, a total material cost is calculated for the segment. This calculation is the material cost per foot multiplied by the number of feet of the feeder segment. Each CBG that utilizes the segment facilities shares the material cost on an equal cost per unit (per line).

Distribution Plant Distances

The design of the plant within a CBG is dependent upon the number of square miles within the CBG, as well as the number of households served within the CBG. First, the CBG is checked to determine if the width of the CBG is greater than twice the maximum copper serving distance (specified by the user). If the width is greater, then the appropriate number of feeder-type legs will be extended into the CBG to sub-divide the area into multiple distribution areas.

The vertical distribution distance per feeder-type leg within the CBG is calculated as width of the CBG divided by the number of feeder-type legs, less two base lot side lengths. The horizontal serving distances for copper facilities within the CBG are calculated as the maximum copper serving distance less one-half the width of the CBG and one base lot side length. However, if the horizontal distances are so large as to require the use of remote terminals on the horizontal legs then the horizontal copper facility distance is calculated as one half the number of base lots between remote terminals multiplied by the base lot side length. Fiber is deployed into the horizontal plant legs when remote terminals are used. In this case, the horizontal plant length is calculated as the width of the CBG, less the distance between remote terminals, less a base side lot length.

Cable Capacity and Material Investments for Distribution Plant

Copper cable and fiber cable capacities for distribution plant are determined in a similar manner as feeder plant. However, distribution plant only provides capacity to serve lines within the CBG. Thus, for distribution plant each of the horizontal plant legs serves an equal portion of the CBG line capacity as do the vertical legs. As with feeder plant the cable sizes (and their cost per foot) deployed by the model are determined by utilizing a "look up" table of the number of lines served by each cable leg (done separately for horizontal and vertical cables) divided by the fill factor for the CBG's specific density group.). The copper distribution cable sizes available in the model are 12, 25, 50, 100, 200, 400, 600, 900, 1200, 1800, 2400, 3000, and 3600 pair. The fiber distribution cable sizes available in the model are 12, 18, 24, 36, 48, 60, 72, 96, and 144 strands.

The total distribution cable material investment is calculated as follows for both copper cable and fiber cable:

$$\begin{aligned} \text{Distribution Cable Investment} = & \text{Number of Horizontal Distribution Legs} * \\ & \text{Horizontal Distribution Distance} * \\ & \text{Horizontal Cable Cost Per Foot} + \\ & \text{Number of Vertical Distribution Legs} * \\ & \text{Vertical Distribution Distance} * \text{Vertical} \\ & \text{Cable Cost Per Foot} \end{aligned}$$

Structure and Placement Costs

Structure and the cost of placing plant include the costs of poles, conduit, innerduct, etc., and the capitalized costs of installing cable and wire facilities plant. The BCM2 uses a cost per foot for structure that varies by plant type, terrain, and density group. It represents the cost of structure and placing the smallest size cables. Each density group and terrain difficulty reflects a different mix of placing activities and structures. The basic structure calculations are done outside the BCM2. Following is an example of the calculations for below ground plant for the three different levels of terrain difficulty associated with the 650 to 850 Households per Sq. Mi. density group.

Activity	\$/FT	650-850 Normal	
		% of Activity	
Plow	0.7		\$ -
Rocky Plow	1.15		\$ -
Trench & Backfill	1.95	25.00%	\$ 0.49
Rocky Trench	2.23		\$ -
Backhoe Trench	2.04	5.00%	\$ 0.10
Hand Dig Trench	2.23	5.00%	\$ 0.11
Bore Cable	12.12	20.00%	\$ 2.42
Push Pipe & Pull Cable	9.8	5.00%	\$ 0.49
Cut & Restore Asphalt	8.23	10.00%	\$ 0.82
Cut & Restore Concrete	10.84	10.00%	\$ 1.08
Cut & Restore Sod	2.06	20.00%	\$ 0.41
		100.00%	\$ 5.93
Conduit	40	0.50%	\$ 0.20
			6.13

650-850 Rock Soft			
Activity	\$/FT	% of Activity	
Plow	0.7		\$ -
Rocky Plow	1.15		\$ -
Trench & Backfill	1.95		\$ -
Rocky Trench	2.23	25.00%	\$ 0.56
Backhoe Trench	2.04	5.00%	\$ 0.10
Hand Dig Trench	2.23	5.00%	\$ 0.11
Bore Cable	12.12	20.00%	\$ 2.42
Push Pipe & Pull Cable	9.8	5.00%	\$ 0.49
Cut & Restore Asphalt	14.23	10.00%	\$ 1.42
Cut & Restore Concrete	16.84	10.00%	\$ 1.68
Cut & Restore Sod	4.1	20.00%	\$ 0.82
		100.00%	\$ 7.61
Conduit	40	0.50%	\$ 0.20
			7.81

650-850 Rock Hard			
Activity	\$/FT	% of Activity	
Plow	0.7		\$ -
Rocky Plow	1.15		\$ -
Trench & Backfill	1.95	5.00%	\$ 0.10
Rocky Trench	10.23		\$ -
Backhoe Trench	2.04		\$ -
Hand Dig Trench	10.23	25.00%	\$ 2.56
Bore Cable	12.12	10.00%	\$ 1.21
Push Pipe & Pull Cable	14.8	10.00%	\$ 1.48
Cut & Restore Asphalt	16.5	25.00%	\$ 4.13
Cut & Restore Concrete	19.2	25.00%	\$ 4.80
Cut & Restore Sod	11.15		\$ -
		100.00%	\$ 14.27
Conduit	40	0.60%	\$ 0.24
			14.51

The tables above display the development of a weighted cost per foot for below ground structure. The first column shows the activity. The second column displays the cost per foot of the activity in that row. The cost per foot data used as the default values in the BCM2 are based on a national average of available

contractor prices for that activity. The third column displays the percent of the activity in the specific density group and terrain difficulty. The final column represents the multiplication of the cost per foot and the percent occurrence of the activity. The final weighted average above is the sum of specific activity prices times the percent occurrence.

The Cost Factor Table in the BCM2 includes a weighted average structure cost per foot for below ground plant and aerial plant. This table includes separate entries for distribution plant, copper feeder plant, and fiber feeder plant by density group by terrain difficulty. Structure costs are adjusted for cable size in the structure cost calculations. As copper cable sizes increase, there are additional handling costs because each cable reel holds less cable. The BCM2 structure costs recognizes these additional handling costs separately for three copper cable size groupings: 600 - 900 pair, 1200 pair, and 1800 pair and above. Additional handling costs for fiber cables are less pronounced and only occur with fiber cables of 72 fiber strands or more. The final element of the structure and placement cost is the cost to pull the largest size cables through conduit. The structure cost calculation follows:

$$\text{Structure Cost} = \text{Density Group Terrain Specific Cost Per Foot} * \text{Cable Length} * \text{Cable Size Factor} + \text{Number of Maximum Size Cables} * \text{Cost Per Foot to Pull Underground Cable Through Conduit}$$

Switch Equipment Investments

Switching investments are calculated based on current central office locations as reported in the LERG. Investments are calculated using generic digital switch investments for five sizes of switch. The BCM2 categorizes the switch at each location either as a remote (if designated as a remote switch in the LERG) or by the number of CBG lines, both residence and business associated with the switch location. The total switching plus interoffice investment per line is calculated as follows:

$$\text{Location Specific Fixed Costs Per Line} =$$

$$((\text{Fixed Cost for Specific Remote/Line Size}) * (\text{NTS \% of Switch} + (1 - \text{NTS \% of Switch}) * (\% \text{ Local DEM})) / \text{Lines at Location}$$

$$\text{Total Switch and Inter-Office Investment Per Line} =$$

$$\text{Land \& Building Factor} * \text{Switch Equip Discount} * \text{Switch Engineering Factor} * \text{Switch InterOffice Investment Ratio} * (\text{Fixed Switch Cost Per Line} + \text{Switch Size Specific Per Line Cost})$$

Circuit Equipment Investments

The BCM2 uses SLC and AFC digital loop carrier equipment investments split between the fixed costs of the remote terminal and digital loop carrier costs that vary by line. The fixed remote terminal costs include the optical line interface units, software, cabinet, power, and the access resource manager common card kit. The per line component includes the line card and shelves at the remote terminal, as well as all the components of the central office terminal.

The circuit equipment investments by CBG are developed through the use of a "look up" table which provides the appropriate fixed terminal cost for the number of lines using the terminal, as well as the cost per line for the individual terminal size. When these investments are found in the table, the discount factor is applied, as well as the engineering and installation factor.

Annual Cost Factors

Throughout the BCM2 process, all cost calculations are derived in terms of investment. In order to determine a monthly cost for basic local service by CBG, the BCM2 uses both investment related expense factors and line related expense factors.

The investment related factors are developed separately for three plant categories: cable and wire facilities, switching equipment, and circuit equipment. For each of these three investment categories, 1995 ARMIS data is used to derive the historical ratio of certain investment related expenses to the gross investment for the plant category. The expense categories include:

- Return on Investment at 11.25 %
- FIT, State, and Local Taxes
- Plant Specific Expenses
- Plant Non-Specific Expenses
- Depreciation/Amortization

Using national 1995 ARMIS data the historical booked expenses were developed. Thus, the factors reflect the historical maintenance expense to investment relationship as well as regulatory-approved depreciation lives. These factors are user adjustable. The BCM2 default values for the three plant category annual cost factors are: